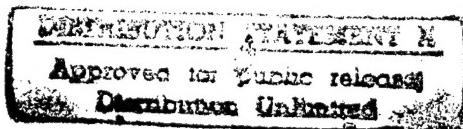


FINAL REPORT
DECEMBER 1992

REPORT NO. 91-14

WOODEN BOX PALLET
MIL-STD-1660 TESTS



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Prepared for:
U.S. Army Defense Ammunition
Center and School
ATTN: SMCAC-DES
Savanna, IL

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VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639

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<p>The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Supply Engineering Division (SMCAC-DES), to test a wooden box pallet. This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted. As tested, the wooden box pallet passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads, tests.</p>				
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REPORT NO. 91-14

WOODEN BOX PALLET MIL-STD-1660 TESTS

TABLE OF CONTENTS

PART	PAGE NO.
1. INTRODUCTION	1-1
A. BACKGROUND	1-1
B. AUTHORITY	1-1
C. OBJECTIVE	1-1
D. CONCLUSION	1-1
E. RECOMMENDATION	1-1
2. ATTENDEES	2-1
3. TEST PROCEDURES	3-1
4. TEST EQUIPMENT	4-1
5. TEST RESULTS	5-1
6. PHOTOGRAPHS	6-1

PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by USADACS, Supply Engineering Division (SMCAC-DES), to test a wooden box pallet.

B. AUTHORITY. This test was conducted IAW mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of this series of tests was to assess the ability of a wooden box pallet to prevent damage during transportation.

D. CONCLUSION. The wooden box pallet performed satisfactorily in all tests in both cases. Although drop tests showed slight deformation, the drop tests were performed at 24 inches which is 12 inches greater than MIL-STD-1660 requirements for a pallet over 3,000 pounds. Also, damage which incurred to banding during the second pallet test was due to circumstances that should not occur during transportation.

E. RECOMMENDATION. Support the lower boards by enclosing them with horizontal banding to prevent nails from pulling out from shock incurred during handling and transportation as was noted during the edgewise rotational drop tests on the first pallet.

PART 2
DECEMBER 1992
ATTENDEES

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PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is to be considered acceptable. The four tests that were conducted on the test pallets are summarized below.

A. STACKING TESTS. The unit load was loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of 1 hour. This stacking load was simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. The compression load was calculated in the following manner. The unit load weight was divided by the unit load height in inches and multiplied by 192. The resulting number was the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test was conducted IAW Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen was placed on, but not fastened to, the platform. With the specimen in one position, the platform was vibrated at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of approximately 3 cycles per second. The frequency was steadily increased until the package left the platform. The resonant frequency was achieved when a 1/16-inch-thick feeler gage momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieved $1 +/ - 0.1$ Gs. Midway into the testing period, the specimen was rotated 90 degrees and the test continued for the duration. Unless failure occurred, the total time of vibration was two hours if the specimen was tested in one position and three hours for more than one position.

C. EDGEWISE ROTATIONAL DROP TEST. This test was conducted using the procedures of Method 5008, Federal Standard 101. The procedure for the edgewise rotational drop test is as follows: The specimen was placed on its skids with one end of the pallet supported on a beam 4-1/2 inches high. The height of the beam was increased if necessary to ensure that there was no support for the skids between the ends of the pallet when dropping took place, but was not high enough to cause the pallet to slide on the supports when the dropped end was raised for the drops. The unsupported end of the pallet was then raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection conforms to the following tabulation:

GROSS WEIGHT NOT EXCEEDING <u>(Pounds)</u>	DIMENSIONS ON ANY EDGE NOT EXCEEDING <u>(Inches)</u>	HEIGHT OF DROP LEVEL A PROTECTION <u>(Inches)</u>
600	72	36
3,000	no limit	24
no limit	no limit	12

D. INCLINE-IMPACT TEST. This test was conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the incline-impact test is as follows: The specimen was placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage was brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber was attached to the bumper in the desired position before the test. No part of the timber was struck by the carriage. The position of the container on the carriage and the sequence in which surfaces

and edges are subjected to impacts was at the option of the testing activity and depends upon the objective of the tests. This test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen was subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact was 7 feet per second.

PART 4

TEST EQUIPMENT

A. TEST PALLET NO. 1.

1. Height:	44 inches (111.76cm)
2. Width:	48 inches (121.92cm)
3. Length:	40 inches (101.60cm)
4. Weight:	3,242 pounds (1473.64kg)

B. TEST PALLET NO. 2.

1. Height:	44 inches (111.76cm)
2. Width:	48 inches (121.92cm)
3. Length:	40 inches (101.60cm)
4. Weight:	3,110 pounds (1413.64kg)

C. COMPRESSION TESTER.

1. Manufacturer:	Ormond Manufacturing
2. Platform:	60- by 60-inches
3. Compression Limit:	50,000 pounds
4. Tension Limit:	50,000 pounds

D. TRANSPORTATION SIMULATOR.

1. Manufacturer:	Gaynes Laboratory
2. Capacity:	6,000-pound pallet
3. Displacement:	1/2-inch amplitude
4. Speed:	50 to 400 rpm
5. Platform:	5- by 8-foot

E. INCLINED RAMP.

1. Manufacturer:	Conbur Incline
2. Type:	Impact Tester
3. Grade:	10 percent incline
4. Length:	12-foot incline

PART 5

TEST RESULTS

A. TEST PALLET NO. 1.

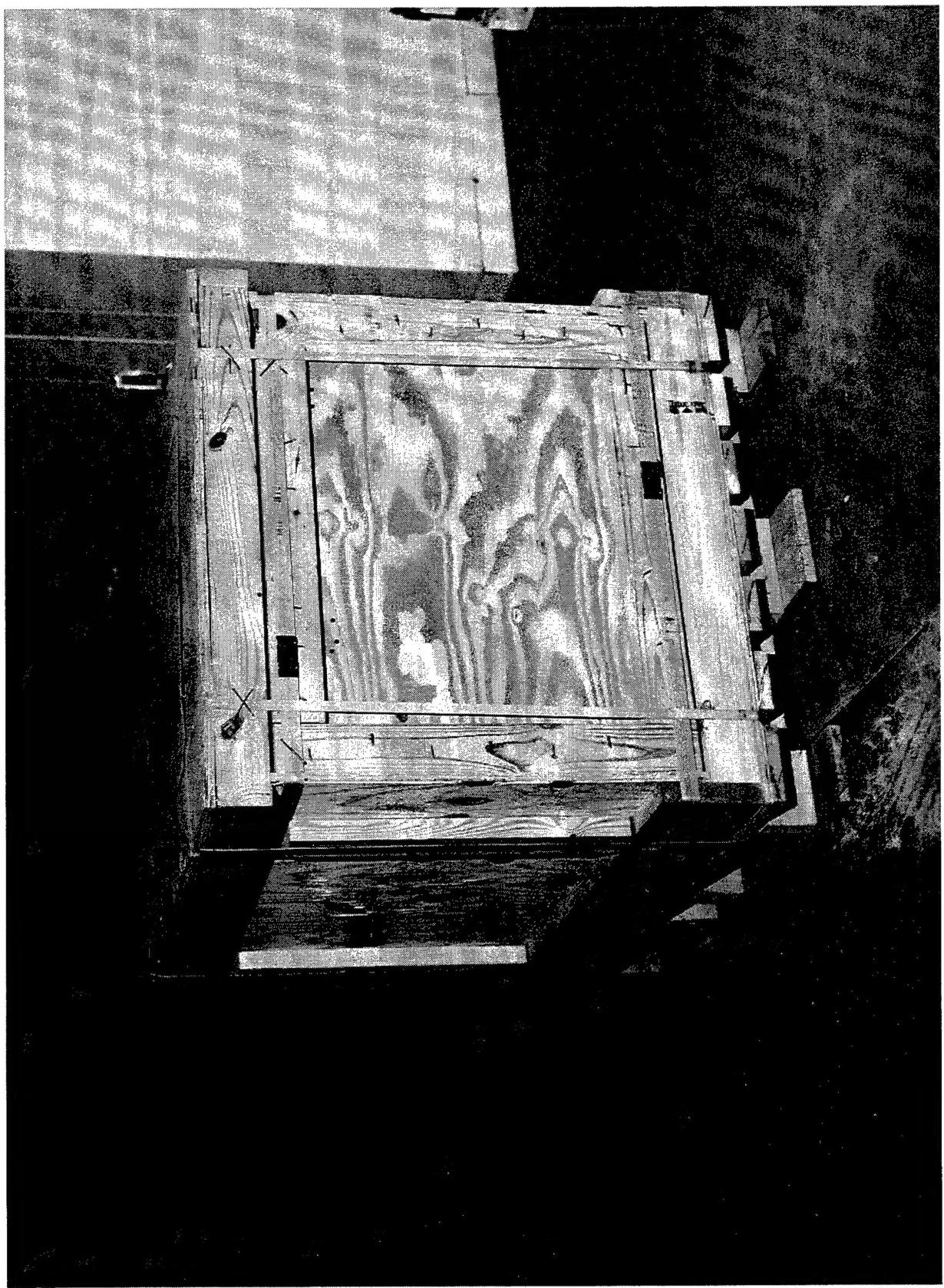
1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 22,694-pounds compression. No damage was noted.
2. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the clearance between the pallet and the transportation simulator bed, the equipment was operated at 195 rpm for the lateral orientation and 205 rpm for the longitudinal orientation. No damage was noted.
3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The ends of the pallet were raised to a height of 24 inches, which is 12 inches higher than required. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. The first drop, to the right side, caused nails to protrude approximately 1/2-inch on the bottom 2- by 4-inch member. The third drop, to the left side of the pallet, caused nails to protrude approximately 1/8-inch on the bottom 2- by 4-inch member on that side (see Part 1.E.).
4. INCLINE-IMPACT TEST. The incline-plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No damage was noted from the tests.
5. END OF TEST INSPECTION. During final inspection, no further damage was noted.

B. TEST PALLET NO. 2.

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 24,780-pounds compression. No damage was noted.
2. REPETITIVE SHOCK TEST. The duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the clearance between the pallet and the transportation simulator bed, the equipment was operated at 210 rpm for the lateral orientation. One 1-1/4-inch band broke and the other 1-1/4-inch band cracked three-fourths of the way through from contact with a weld on the test equipment. This is not critical to the test since it was due to circumstances of the test. The pallet was then vibrated at 205 rpm for the longitudinal orientation. No other damage was noted.
3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2-inches above the floor. The ends of the pallet were raised to a height of 24 inches, which is 12 inches higher than required. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. The damaged band from the repetitive shock test broke during the first drop. Testing continued with no other damage.
4. INCLINE-IMPACT TEST. The incline-plane was set to allow the pallet to travel 8 feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No damage was noted from the tests.
5. END OF TEST INSPECTION. During final inspection, slight cracking was noted on one side. The cracking was minor as it was only superficial.

PART 6

PHOTOGRAPHS



U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL -
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AO317-SCN-96-123-2382. This photo shows the second test pallet following testing. Note the cracking on the side.



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AO317-SCN-96-123-2383. This photo shows the damaged side of the second pallet. Note the broken band and cracking of the rear plywood face.